CLAIMS

What is claimed is:

1. A process for the preparation of a plurality of well-defined structures of at least one electronic device, said process including the imagewise exposure of radiation sensitive material, said process comprises the steps of:

(a) providing a support web;

(b) providing a layer of radiation sensitive composition coated on said support web;

(c) providing a pre-patterned photomask, said photomask comprises a strip formed as a continuous loop, said photomask pattern corresponding in form to at least one of said structures so as to permit an image of said structure to be projected by radiation passing through said photomask;

(d) aligning said photomask loop adjacent to said support web so that a portion of said photomask loop is in generally parallel orientation to at least a portion of said web,

(e) selectively imagewise exposing said radiation sensitive material by passage of radiation through said photomask;

(f) rolling said photomask loop in synchronized motion relative to said support web, said synchronized motion includes moving at least a portion of said photomask loop and at least a portion of said web in parallel in substantially the same direction.

2. A process as in Claim **1,** wherein:

said step of rolling said photomask loop includes moving at least a portion of said photomask loop and at least a portion of said web in parallel in substantially the same direction and at substantially the same velocity during said exposure step.

3. A process as in Claim **2,** wherein:

(a) said step of providing an elongate support web includes that said web comprises a plurality of conductor lines for addressing microcups of at least one display device;

(b) said step providing a layer of radiation sensitive composition includes that said composition is a radiation curable material for said structures, said structures are a plurality of microcups disposed as a microcup array for at least one display device;

(c) said step of providing a pre-patterned photomask includes that said photomask pattern corresponding in form to said plurality of microcups, so as to permit an image of said microcups to be projected by radiation passing through said photomask;

(d) said step of selectively exposing said radiation sensitive material includes selectively curing a portion of said radiation curable precursor material while a portion of said radiation curable material remains uncured, said selectively cured portion corresponding to said plurality of microcups; and

(e) said process includes the step of selectively removing said uncured portion of said radiation curable material while leaving on said web said selectively cured portion, so as to form said microcup array.

4. A process as in Claim **2,** wherein:

(a) said step of providing a support web includes that said web comprises a plurality of pre-formed microcups disposed in an microcup array for at least one display device, each of said microcups having a top opening;

(b) said step of providing a layer of radiation sensitive composition includes that said composition is a positively working photoresist composition, and that said layer is deposited upon said microcup array to close said plurality of microcup top openings;

(c) said step of providing a pre-patterned photomask includes that said photomask pattern corresponds in form to said top openings of a first selected subset of said plurality of microcups, so as to permit an image of said top openings of said first microcup subset to be projected by radiation passing through said photomask;

(d) said step of selectively exposing said radiation sensitive material includes selectively exposing the portion of said photoresist layer coordinate with said microcup top openings of said first selected microcup subset;

(e) said process includes the step of selectively removing said exposed portion of said photoresist layer so as to selectively re-open the top openings of said first selected microcup subset;

5. A process as in Claim **4,** wherein said process includes the steps of:

(a) selectively filling said first microcup subset via said re-opened microcup top openings with at least one of: a first electrophoretic display pigment/solvent composition and a first liquid crystal composition; and

(b) permanently closing and sealing said re-opened top openings of said first microcup subset.

6. A process as in Claim **5,** wherein:

following said step of permanently closing and sealing said re-opened top openings of said first microcup subset, said process includes the steps of:

(a) repeating said photomask providing step, said photomask pattern corresponds in form to said top openings of a second selected subset of said plurality of microcups, so as to permit an image of said top openings of said second microcup subset to be projected by radiation passing through said photomask;

(b) repeating said aligning step, said selectively imagewise exposing step, said rolling step, and said selectively removing steps, so as to selectively re-open said top openings of said second microcup subset;

(c) selectively filling said second microcup subset via said re-opened microcup top openings with at least one of: a second electrophoretic display pigment/solvent composition and a second liquid crystal composition; and

(d) permanently closing and sealing said re-opened top openings of said second microcup subset.

7. A process as in Claim **6,** wherein:

following said step of permanently closing and sealing said re-opened top openings of said second microcup subset, said process includes the steps of:

(a) removing said photoresist layer for at least the top openings of a third subset of microcups;

(b) filling said third microcup subset via said re-opened microcup top openings with at least one of: a third electrophoretic display pigment/solvent composition and a third liquid crystal composition; and

(c) permanently closing and sealing said re-opened top openings of said third microcup subset.

8. A process as in Claim **7,** said process includes the steps of:

laminating upon said microcup array a top laminate, said top laminate includes a plurality of pre-patterned transparent conductor lines for addressing microcups of at least one display device.

9. A continuous process for the preparation of an assembled microcup array for at least one display device, said process comprises the steps of:

(a) carrying out the process of Claim **3**, so as to form said microcup array upon said support web, each of said microcups having a top opening;

(b) moving said web so as to permit at least one subsequent process step to be performed on said microcup array in a generally continuous manner;

(c) filling at least a subset of said microcups via said top openings with a fluid composition including at least one of: an electrophoretic display pigment/solvent composition and a liquid crystal display composition, and permanently closing and sealing said at least a subset of top openings of said microcups; and

(d) laminating upon said microcup array a top laminate, said top laminate includes a plurality of pre-patterned conductor lines for addressing microcups of at least one display device, so as to form an assembled microcup array for said at least one display device.

10. A continuous process as in Claim **9,** wherein:
said step of filling, sealing and closing comprise filing substantially all of said microcups with a single fluid composition, so as to form an assembled microcup array for at least one monochrome display device.

11. A continuous process as in Claim **9,** wherein:
said steps of filling, sealing and closing comprise carrying out the process of Claim **7** to selectively fill a plurality of microcup subsets with a plurality of different fluid compositions, so as to form an assembled microcup array for at least one multi-color display device.

12. A process for the preparation of a plurality of well-defined structures of at least one electronic device, said structures being disposed coordinate with a plurality of elements of said at least one electronic device, said process including the

imagewise exposure of radiation sensitive material, said process comprises the steps of:

(a) providing a support web having a surface;

i. said support web includes a plurality of elements of said at least one electronic device;

ii. said elements being disposed in a repeated longitudinal pattern along said support web;

(b) coating a layer of radiation sensitive composition on said support web;

(c) providing a pre-patterned photomask;

i. said photomask comprises a strip formed as a continuous loop;

ii. said photomask loop is configured to have a loop face adjacent to at least a portion of said web surface;

iii. said photomask pattern includes a plurality of photomask portions, each of said photomask portions having one of pre-selected transparency to radiation and pre-selected opacity to radiation corresponding in form to one of said plurality of structures;

(d) aligning said photomask loop face in generally parallel orientation adjacent to said support web surface, including aligning in a predetermined spatial relationship at least one of said plurality of elements to at least one of said plurality of photomask portions;

(e) selectively imagewise exposing said radiation sensitive material by passage of radiation through said photomask;

(f) moving said photomask loop face in synchronized motion relative to said support web surface, said synchronized motion includes moving said loop face and said web surface in parallel in the substantially the same direction for substantially the same distance so as to maintain said alignment in a predetermined spatial relationship.

13. A process as in Claim **12**, wherein:
said step of moving said photomask loop face in synchronized motion includes moving said loop face and said web surface at substantially the same velocity.

14. A process as in Claim **12**, wherein:
said step of moving said photomask loop face in synchronized motion includes moving said loop face and said web surface at a constant relative velocity.

15. A process as in Claim **13**, wherein:
said step of moving said photomask loop face in synchronized motion is carried out generally simultaneously with said step of exposing said radiation sensitive material.

16. A process as in Claim **15**, wherein:
said steps of moving said photomask loop face in synchronized motion and exposing said radiation sensitive material are carried out generally continuously.

17. A process as in claim **16**, wherein:
said step of coating a layer of radiation sensitive composition is carried out generally continuously.

18. A process as in Claim **15**, wherein:
said step of coating a layer of radiation sensitive composition includes that said layer is one of::
(a) a radiation curable precursor material for said structures; and
(b) a photoresist composition;

19. A process as in Claim **15**, wherein:

said step aligning said photomask loop includes:

(a) detecting at least one of:

i. one of said elements of said web; and

ii. a pre-formed marker on said web;

(b) detecting at least one of said photomask portions;

i. one of said portions of said photomask; and

ii. a pre-formed marker on said photomask, and;

(c) controlling the motion of at least one of said web and said photomask face in response to said detections, so as to bring at least one photomask portion into a predetermined spatial relationship with at least one photomask portion.

20. A process as in Claim **16,** wherein:

(a) said step of providing a support web includes that said plurality of elements of said at least one electronic device includes a plurality of pre-patterned conductor lines for addressing microcups of an electronic display;

(b) said step of coating a layer of radiation sensitive composition includes:

i. said composition is a radiation curable material for said structures; and

ii. said structures are a plurality of microcups disposed in an array for at least one electronic display

iii. said microcups comprising surrounding microcup walls;

(c) said step of providing a pre-patterned photomask includes each of said plurality of photomask portions corresponds in form to at least a wall of one of said plurality of microcups;

(d) said step of aligning in a predetermined spatial relationship includes aligning at least one of said plurality of conductor lines coordinate with at least one of said plurality of photomask portions corresponding to microcups;

(e) said step of selectively exposing said radiation sensitive material includes selectively curing a portion of said radiation curable precursor material while a portion of said radiation curable precursor material remains uncured, said selectively cured portion corresponding to said microcup walls.

21. A process as in Claim **20,** wherein said process includes the step of:
following said step of selectively exposing said radiation sensitive material, selectively removing said uncured portion of said radiation curable precursor material while leaving said selectively cured portion corresponding to said microcup walls.

22. A process as in Claim **21,** wherein:
said step of selectively removing said uncured portion of said radiation curable precursor material is carried out generally continuously.

23. A process as in Claim **16,** wherein:
(a) said step of providing a support web includes that said web comprises a pre-formed array of a plurality of microcups for at least one electronic display, each of said microcups having a top opening ;
(b) said step of coating a layer of radiation sensitive composition includes:
   i. said composition is a positively working photoresist composition; and
   ii. said coating step includes depositing said layer upon said microcup array to close and seal said microcup top openings;
(c) said step of providing a pre-patterned photomask includes that each of said plurality of photomask portions has a pre-selected transparency to radiation corresponds in form to one of a first selected subset of said plurality of microcups top openings; and

(d) said step of selectively exposing said radiation sensitive material includes selectively exposing the portion of said photoresist layer coordinate with said microcup top openings of said first selected microcup subset.

24. A process as in Claim **23,** wherein said process includes the step of:
following said step of selectively exposing said photoresist layer, selectively removing said exposed portion of said photoresist layer so as to selectively re-open the top openings of said first selected microcup subset.

25. A process as in Claim **24,** wherein:
following said step of selectively removing said exposed portion of said photoresist, said process includes the steps of:
(a) selectively filling said first microcup subset via said re-opened microcup top openings with at least one of:
i. a first electrophoretic display pigment/solvent composition; and
ii. a first liquid crystal composition;
(b) permanently closing and sealing said re-opened top openings of said first microcup subset.

26. A process as in Claim **25,** wherein:
following said step of permanently closing and sealing said re-opened top openings of said first microcup subset, said process includes the steps of:
(a) repeating said photomask providing step by providing a second photomask, said second photomask including photomask portions corresponding in form to the top openings of a second selected subset of said microcups;
(b) repeating said aligning, moving, selectively imagewise exposing, and selectively removing steps with respect to said second photomask and said

second microcup subset, so as to selectively re-open said top openings of said second microcup subset;

(c) selectively filling said second microcup subset via said re-opened microcup top openings with at least one of:

i. a second electrophoretic display pigment/solvent composition; and

ii. a second liquid crystal composition;

(d) permanently closing and sealing said re-opened top openings of said second microcup subset.

27. A process as in Claim **26,** wherein:

said step of providing a web includes providing a microcup array, said array includes at least a third subset of microcups distinct from said first and second subsets; and wherein following said step of permanently closing and sealing said re-opened top openings of said second microcup subset, said process includes the steps of:

(a) removing said photoresist layer for at least the top openings of said third subset of microcups;

(b) filling said third microcup subset via said re-opened microcup top openings with at least one of:

iii. a third electrophoretic display pigment/solvent composition; and

iv. a third liquid crystal composition;

(c) permanently closing and sealing said re-opened top openings of said third microcup subset.

28. A process as in claim 27, said process includes the steps of:

laminating upon said sealed microcup array a top laminate, said top laminate includes a plurality of pre-patterned conductor lines for addressing microcups of at least one display device.

29. A process as in claim 28, said process includes the steps of:
depositing a layer of adhesive between the said sealed microcup array and said pre-patterned conductor lines by coating or lamination.

30. An apparatus for the preparation of a plurality of well-defined structures of at least one electronic device by the imagewise exposure of a layer of radiation sensitive material coated upon a support web, comprising:

(a) a web drive mechanism engaging said support web so as to movably guide said web;

(b) a pre-patterned photomask, said photomask comprises a strip formed as a continuous loop;

(c) a photomask alignment mechanism engaging said photomask, said alignment mechanism is mounted adjacent said web so as to align said photomask loop adjacent to said web so that a portion of said photomask loop is in generally parallel orientation to at least a portion of said web;

(d) a photomask drive mechanism engaging said photomask for rolling said photomask loop, said photomask drive mechanism is synchronizable with said web drive mechanism so as to permit rolling said photomask loop in synchronized motion relative to said support web, said synchronized motion includes moving at least a portion of said photomask loop and at least a portion of said web in parallel in substantially the same direction;

(e) said photomask pattern corresponds in form to at least one of said structures so as to permit an image of said structure to be projected by radiation passing through said photomask; and

(f) a radiation source mounted in cooperative alignment with said photomask and said web so as to permit the selective imagewise exposure of said radiation sensitive material by passage of radiation through said photomask.

31. An apparatus as in Claim **30,** wherein:

said synchronized motion of said synchronizable photomask drive mechanism includes moving at least a portion of said photomask loop and at least a portion of said web in parallel at substantially the same velocity.

32. An apparatus as in Claim **31,** wherein:

(a) said support web includes a plurality of conductor lines for addressing microcups of at least one display device;

(b) said layer of radiation sensitive composition is a radiation curable material for said structures, said structures are a plurality of microcups disposed as a microcup array for at least one display device; and

(c) said photomask pattern corresponds in form to said plurality of microcups, so as to permit selectively exposing said precursor material by an image of said microcups projected by radiation from said radiation source passing through said photomask so as to selectively cure a portion of said precursor material while a portion of said precursor material remains uncured, said selectively cured portion corresponding to said plurality of microcups.

33. An apparatus as in Claim **32,** further comprising:

a solvent application mechanism mounted adjacent said web so as to permit the application of at least a solvent for removing said uncured portion of said precursor material while leaving on said web said selectively cured portion, so as to form said microcup array upon said web.

34. An apparatus as in Claim **31,** wherein:

(a) said support web includes a plurality of pre-formed microcups disposed in an microcup array for at least one display device, each of said microcups having a top opening;

(b) said layer of radiation sensitive composition is a positively working photoresist composition deposited upon said microcup array so as to close said plurality of microcup top openings; and

(c) said photomask is a first photomask having a first pattern; and

(d) said first photomask pattern corresponds in form to said top openings of a first selected subset of said plurality of microcups, so as to permit selectively exposing said photoresist layer by an image of said top openings of said first microcup subset by radiation passing through said first photomask so as to expose the portion of said photoresist layer coordinate with said top openings of said first selected microcup subset while a portion of said photoresist layer remains unexposed.

35. An apparatus as in Claim **34,** further comprising:

a solvent application mechanism mounted adjacent said web so as to permit application of at least a solvent for removing said exposed portion of said photoresist layer while leaving on said microcup array said unexposed portion, so as to selectively re-open the top openings of said first selected microcup subset.

36. An apparatus as in Claim **35,** further comprising:

(a) a first microcup filling mechanism mounted adjacent said web so as to permit the selective filling of said first microcup subset via said re-opened microcup top openings with at least one of: a first electrophoretic display pigment/solvent composition and a first liquid crystal display composition; and

(b) a first microcup sealing mechanism mounted adjacent said web so as to permit the permanent closing and sealing said re-opened top openings of said first microcup subset.

37. An apparatus as in Claim **36,** further comprising:

(a) a second prepatterned photomask having a second pattern;

(b) a second photomask alignment mechanism engaging said second photomask, said second alignment mechanism is mounted adjacent said web so as to align said second photomask loop adjacent to said web so that a portion of said photomask loop is in generally parallel orientation to at least a portion of said web;

(c) a second photomask drive mechanism engaging said second photomask for rolling said second photomask loop, said second photomask drive mechanism is synchronizable with said web drive mechanism so as to permit rolling said second photomask loop in synchronized motion relative to said support web, said synchronized motion includes moving at least a portion of said second photomask loop and at least a portion of said web in parallel at substantially the same velocity; and

(d) a second radiation source mounted in cooperative alignment with said second photomask and said web so as to permit the selective imagewise exposure of said radiation sensitive material by passage of radiation through said second photomask.

(e) said second photomask pattern corresponds in form to said top openings of a second selected subset of said plurality of microcups, so as to permit selectively exposing said photoresist layer by an image of said top openings of said second microcup subset, and so as to expose the portion of said photoresist layer coordinate with said top openings of said second selected microcup subset while a portion of said photoresist layer remains unexposed.

(f) a second solvent application mechanism mounted adjacent said web so as to permit the application of at least a solvent for removing said exposed portion of said photoresist layer while leaving on said microcup array said unexposed portion, so as to selectively re-open the top openings of said second selected microcup subset;

(g) a second microcup filling mechanism mounted adjacent said web so as to permit the selective filling of said second microcup subset via said re-opened microcup top openings with at least one of: a second electrophoretic display pigment/solvent composition and a second liquid crystal composition; and

(h) a second microcup sealing mechanism mounted adjacent said web so as to permit the permanent closing and sealing said re-opened top openings of said second microcup subset.

38. An apparatus as in Claim **37,** further comprising:

(a) a third solvent application mechanism mounted adjacent said web so as to permit the application of at least a solvent for removing said photoresist layer on a third subset of said plurality of microcups of said microcup array, so as to re-open the top openings of said third microcup subset;

(b) a third microcup filling mechanism mounted adjacent said web so as to permit the filling of said third microcup subset via said re-opened microcup top openings with at least one of: a third electrophoretic display pigment/solvent composition and a third liquid crystal composition; and

(c) a third microcup sealing mechanism mounted adjacent said web so as to permit the permanent closing and sealing said re-opened top openings of said third microcup subset.

39. An apparatus as in Claim 38, further comprising:

a laminating mechanism mounted adjacent said web so as to permit the adhesive lamination upon said microcup array of a top laminate, said top laminate includes a plurality of pre-patterned conductor lines for addressing microcups of at least one display device.

40. A process as in Claim 2, wherein the conductor lines are transparent to visible light.

41. A process as in Claim 8, wherein the conductor lines are transparent to visible light.

42. A process as in Claim 20, wherein the conductor lines are transparent to visible light.

43. A process as in Claim 28, wherein the conductor lines are transparent to visible light.

44. A process as in Claim 32, wherein the conductor lines are transparent to visible light.

45. A process as in Claim 39, wherein the conductor lines are transparent to visible light.

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